Translation for JP2003-427892

Claims

1. A node which newly joins a network formed by a plurality of nodes, the node comprising:

a virtual connection establisher unit configured to establish virtual connections with the plurality of nodes;

an average metric value calculator unit configured to calculate an average metric value of routes to the plurality of nodes via each of the virtual connections; and

a connection establisher unit configured to establish a connection with the node to which the virtual connection having the smallest average metric value is established.

2. The node according to claim 1, further comprising:

an acquirer unit configured to acquire node-node connection information of an adjacent node to any node forming the network, from the any node; and wherein

the average metric value calculator unit is configured to calculate the average metric value in accordance with the node-node connection information.

3. The node according to claim 2, wherein

the node-node connection information includes a node ID for identifying the adjacent node, a metric value of a route between the any node and the adjacent node, and the number of nodes adjacent to the adjacent node.

4. The node according to claim 3, wherein

the metric value includes at least one of the number of hops, network bandwidth, communication costs, delay, load, MTU, or reliability.

5. A method for generating a network topology in which a new node joins a network formed by a plurality of nodes, the method comprising:

establishing a virtual connection between the new node and each of the plurality of nodes;

calculating an average metric value of routes from the new node to the plurality of nodes via each of the virtual connections; and

establishing a connection between the new node and the node to which the virtual connection having the smallest average metric value is established, so that the

new node joins the network.

Description

[Name of Invention] NETWORK TOPOLOGY GENERATION METHOD AND NODE

[Technical Field]

The present invention relates to a method for generating a network topology in which a new node joins a network formed by a plurality of nodes. The present invention also relates to a node which newly joins a network formed by a plurality of nodes.

[Background Art]

Referring to FIGS. 13 to 17, a conventional method for generating a network topology (a method used in the "Gnutella") will be explained. To be more specific, an operation in which a node 105 newly joins a network including nodes 101 to 104.

First, as shown in FIG. 13, the node 105 selects a node 101 which IP address or URL the node 105 knows, among from a plurality of nodes 101 to 104 which forms the network, so as to establish a connection with the node 101.

Second, as shown in FIG. 14, the node 105 transmits a PING message via broadcast including an IP address of the node 105 to the node 101.

Third, as shown in FIG. 15, the node 101 returns a PONG message including an IP address of the node 101 to the node 105, and transfers the PING message including the IP address of the node 105 to nodes 102 to 104.

Fourth, as shown in FIG. 16, each of the nodes 102 to 104 returns PONG messages including respective IP addresses to the node 105.

The node 105 can acquire the IP address of nodes in the range designated in the TTL (Time to Live) field of the PING message, by repeating the above mentioned procedure.

Fifth, as shown in FIG. 17, the node 105 establishes connections with each of the nodes 101 to 104 which forms the network, by referring to the IP address included in the received PONG messages.

Thus, the node 105 can newly join the network formed by the nodes 101 to 104.

(Patent literature 1) JP2003-304277

[Disclosure of Invention]

[The Problem to be Solved by the Invention]

As described above, in the conventional method for generating a network topology, the new node 105 was composed to join the network randomly by using PING

and PONG messages.

However, in the conventional method for generating a network topology, a network condition in a physical layer is not considered, upon generating a new network topology.

Therefore, there is a possibility that a network delay is considerably large between adjacent nodes in a logical layer, and there is a possibility that data transfer efficiency is reduced in a newly generated network.

In viewing of the foregoing, it is an object of the present invention to provide a network topology generation method and a node which can reduce a network delay fairly and minimally, upon generating a new network topology, by considering a network condition in a physical layer.

[The Means for Solving the Problem]

A first aspect of the present invention is summarized as a node which newly joins a network formed by a plurality of nodes. The node includes a virtual connection establisher unit configured to establish virtual connections with the plurality of nodes; an average metric value calculator unit configured to calculate an average metric value of routes to the plurality of nodes via each of the virtual connections; and a connection establisher unit configured to establish a connection with the node to which the virtual connection having the smallest average metric value is established.

In such invention, the connection establishing unit can reduce the network delay fairly and minimally, upon generating a new network topology, because the connection establishing unit establishes a connection with the node to which the virtual connection has been established so that the average metric value, which is calculated by considering a network condition in a physical layer, becomes the smallest.

In the first aspect, the node can further include an acquirer unit configured to acquire node-node connection information of an adjacent node to any node forming the network, from the any node. And, the average metric value calculator unit can be configured to calculate the average metric value in accordance with the node-node connection information.

In the first aspect, the node-node connection information can include a node ID for identifying the adjacent node, a metric value of a route between the any node and the adjacent node, and the number of nodes adjacent to the adjacent node.

In the first aspect, the metric value can include at least one of the number of hops, network bandwidth, communication costs, delay, load, MTU, or reliability.

A second aspect of the present invention is summarized as a method for generating a network topology in which a new node joins a network formed by a

plurality of nodes. The method includes establishing a virtual connection between the new node and each of the plurality of nodes; calculating an average metric value of routes from the new node to the plurality of nodes via each of the virtual connections; and establishing a connection between the new node and the node to which the virtual connection having the smallest average metric value is established, so that the new node joins the network.

[The Effect of the Invention]

As explained above, the present invention makes it possible to provide a network topology generation method and a node which can reduce a network delay fairly and minimally, upon generating a new network topology, by considering a network condition in a physical layer.

[Best Mode for Carrying Out the Invention]

<A configuration of a node for achieving a network topology generation method according to a first embodiment of the present invention>

Referring to FIG 1, a configuration of a node for achieving a network topology generation method according to a first embodiment of the present invention will be described. In this embodiment, a node X is configured to be able to newly join a network including a plurality of nodes A to D.

As shown in FIG 1, a node X according to this embodiment includes a node-node connection information acquiring unit 11, a virtual connection establishing unit 12, an average metric value calculating unit 13, a connection establishing unit 14.

The node-node connection information acquiring unit 11 is configured to acquire, from any node forming the network, node-node connection information of adjacent nodes to the any node. Note that, the node-node connection information includes a "node name (node ID)" for identifying the adjacent node, a "node address (for example, an IP address)" of the adjacent node, a "metric value" of a route between the any node and the adjacent node, and "the number of nodes" adjacent to the adjacent node. The metric value includes at least one of "the number of hops", "network bandwidth", "communication costs", "delay", "load", "MTU", or "reliability".

The virtual connection establishing unit 12 is configured to establish virtual connections with a plurality of nodes A to D, by referring to node addresses included in the node-node connection information acquired by the node-node connection information acquiring unit 11.

The average metric value calculating unit 13 is configured to calculate an average metric value of routes to the plurality of nodes A to D via each of the virtual connections, by using the node-node connection information acquired by the node-node

connection information acquiring unit 11. A specific method for calculating the average metric value will be described later.

The connection establishing unit 14 is configured to establish a connection with the node to which the virtual connection having the smallest average metric value is established.

<An operation of the network topology generation method according to the embodiment>

Referring to FIGS. 2 to 12, an operation of the network topology generation method according to the embodiment will be explained. To be more specific, an operation in which the node X newly joins the network including the nodes A to D will be explained.

As shown in FIGS. 2 and 3, in step S1, the node-node connection information acquiring unit 11 of the node X acquires node-node connection information managed by the node A (the above described "any node"), from the node A.

FIG. 4 shows the node-node connection information managed by the node A, in this embodiment. As shown in FIG. 4, the adjacent nodes to the node A is the nodes B to D.

Here, the node address of the node B is "B_{IP}", the node address of the node C is "C_{IP}", and the node address of the node D is "D_{IP}". The metric value between the node A and the node B is "2", the metric value between the node A and the node C is "3", and the metric value between the node A and the node D is "2". The number of nodes adjacent to the node B is "2", the number of nodes adjacent to the node C is "2", and the number of nodes adjacent to the node D is "3".

As shown in FIG. 2 and 5, in step S2, the virtual connection establishing unit 12 of the node X establishes virtual connections with the nodes A to D, in accordance with the "node addresses" included in the acquired node-node connection information.

In step S3, the average metric value calculating unite 13 of the node X calculates an average metric value of routes from the node C to each of the nodes A to D via each virtual connection, in accordance with the "metric values" and "the numbers of the nodes" included in the included in the acquired node-node connection information.

To be more specific, the average metric value is calculated as follows.

Here, it is assumed that the metric value of the virtual connection #1 established between the node X and the node D is "1", the metric value of the virtual connection #2 established between the node X and the node A is "5", the metric value of the virtual connection #3 established between the node X and the node B is "3", and the metric value of the virtual connection #4 established between the node X and the node

C is “1”.

FIG. 6 shows route information for associating the “metric value” of the routes #A1 to #D1 from the node X to the each of the nodes A to D via the virtual connection #1, with “the number of nodes” adjacent to each of the nodes A to D.

FIG. 7 shows route information for associating the “metric value” of the routes #A2 to #D2 from the node X to the each of the nodes A to D via the virtual connection #2, with “the number of nodes” adjacent to each of the nodes A to D.

FIG. 8 shows route information for associating the “metric value” of the routes #A3 to #D3 from the node X to the each of the nodes A to D via the virtual connection #3, with “the number of nodes” adjacent to each of the nodes A to D.

FIG. 9 shows route information for associating the “metric value” of the routes #A4 to #D4 from the node X to the each of the nodes A to D via the virtual connection #4, with “the number of nodes” adjacent to each of the nodes A to D.

The average metric value calculating unit 13 calculates an average metric value V_i of routes from the node X to the node i via each of the virtual connections #1 to #4, by the expression as shown in FIG. 10 with the route information as shown in FIGS. 6 to 9.

In the expression shown in FIG. 10, “n” means the total number of nodes belonging to the network, “V_{Mi}” means a metric value of a route from the node X to the node i, and “N_i” means a value calculated by adding “1” to the number of nodes adjacent to the node i.

Here, it is assumed that the node A corresponds to the node 1, the node B corresponds to the node 2, the node C corresponds to the node 3, and the node D corresponds to the node 4.

FIG. 11 shows an example of a situation where the average metric value calculating unit 13 of the node X calculates the average metric value of routes from the node X to each of the nodes A to D via each of the virtual connections #1 to #4, by referring to the route information as shown in FIGS. 6 to 9.

As shown in FIG. 11, the average metric value of the routes from the node X to the each of the nodes A to D via the virtual connection #2 established between the node X and the node A is “78/11”.

The average metric value of the routes from the node X to the each of the nodes A to D via the virtual connection #3 established between the node X and the node B is “59/11”.

The average metric value of the routes from the node X to the each of the nodes A to D via the virtual connection #4 established between the node X and the node C is

"50/11".

The average metric value of the routes from the node X to the each of the nodes A to D via the virtual connection #1 established between the node X and the node D is "40/11".

As a result, in step S4, the connection establishing unit 14 of the node X establishes a connection with the node D to which the virtual connection #1 having the smallest average metric value ("40/11") is established, as shown in FIG. 12.

As a result, the node X joins the network and the network topology is changed. In other words, the node X can communicate with all nodes in the network such as the nodes A to D, via the virtual connection #1.

<Functions and effects of the network topology generation method according to the embodiment>

According to the network topology generation method of the embodiment, the connection establishing unit 14 of the node X establishes a connection with the node D to which the virtual connection #1 is established, so that the average metric value calculated by considering the network condition in the physical layer is the smallest. Therefore, it is possible to reduce the network delay fairly and minimally, upon generating a new network topology.

[Brief Description of the Drawing]

FIG. 1 is a functional block diagram of a node according to one embodiment of the present invention;

FIG. 2 is a diagram showing an operation in which a node X according to the embodiment of the present invention newly joins a network;

FIG. 3 is a diagram showing an operation in which the node X according to the embodiment of the present invention acquires node-node connection information from a node A;

FIG. 4 is a diagram showing an example of the node-node connection information acquired by the node X according to the embodiment of the present invention;

FIG. 5 is a diagram showing an operation in which the node X according to the embodiment of the present invention establishes virtual connections with nodes A to D;

FIG. 6 is a diagram showing information of routes from the node X to each node A to D via the virtual connection established between the node X according to the embodiment of the present invention and the node D;

FIG. 7 is a diagram showing information of routes from the node X to each node A to D via the virtual connection established between the node X according to the

embodiment of the present invention and the node A;

FIG. 8 is a diagram showing information of routes from the node X to each node A to D via the virtual connection established between the node X according to the embodiment of the present invention and the node B;

FIG. 9 is a diagram showing information of routes from the node X to each node A to D via the virtual connection established between the node X according to the embodiment of the present invention and the node C;

FIG. 10 is a diagram showing an expression with which the node X according to the embodiment of the present invention calculates an average metric value of routes to the nodes A to D via each virtual connection;

FIG. 11 is a diagram showing an example in which the node X according to the embodiment of the present invention calculates an average metric value of routes to the nodes A to D via each virtual connection; and

FIG. 12 is a diagram showing an operation in which the node X according to the embodiment of the present invention establishes a connection with the node D.

FIG. 13 is a diagram showing an operation in which a node 105 establishes a connection with a node 101, in a prior art;

FIG. 14 is a diagram showing an operation in which the node 105 transmits a PING message to the node 101, in a prior art;

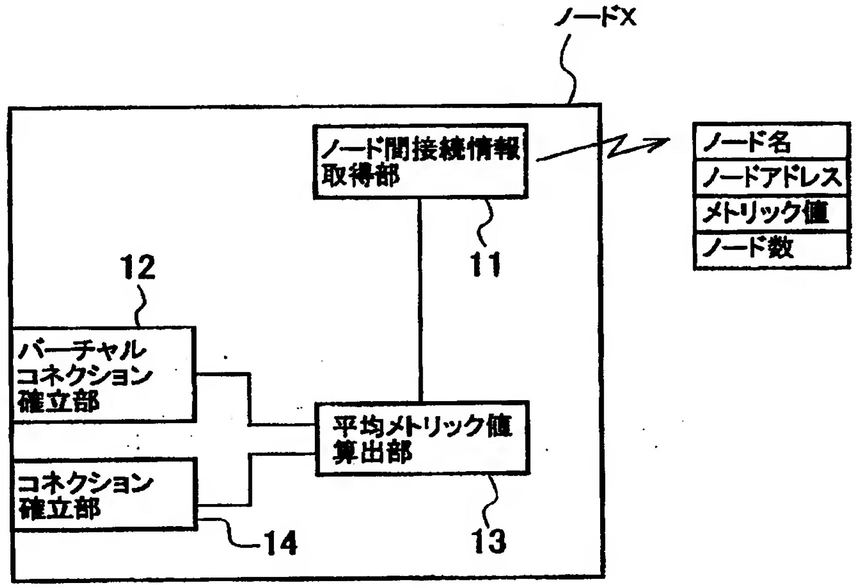
FIG. 15 is a diagram showing an operation in which the node 101 returns a PONG message to the node 105, and transmits the PING messages to nodes 102 to 104, in a prior art;

FIG. 16 is a diagram showing an operation in which each of the nodes 102 transmits PONG messages to the node 101, in a prior art;

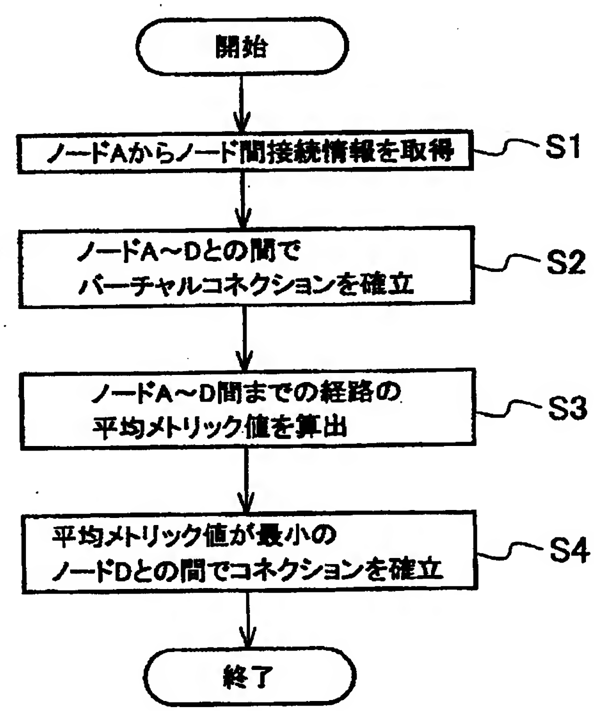
FIG. 17 is a diagram showing an operation in which the node 101 establishes connections with the nodes 102 to 104, in a prior art;

【書類名】図面

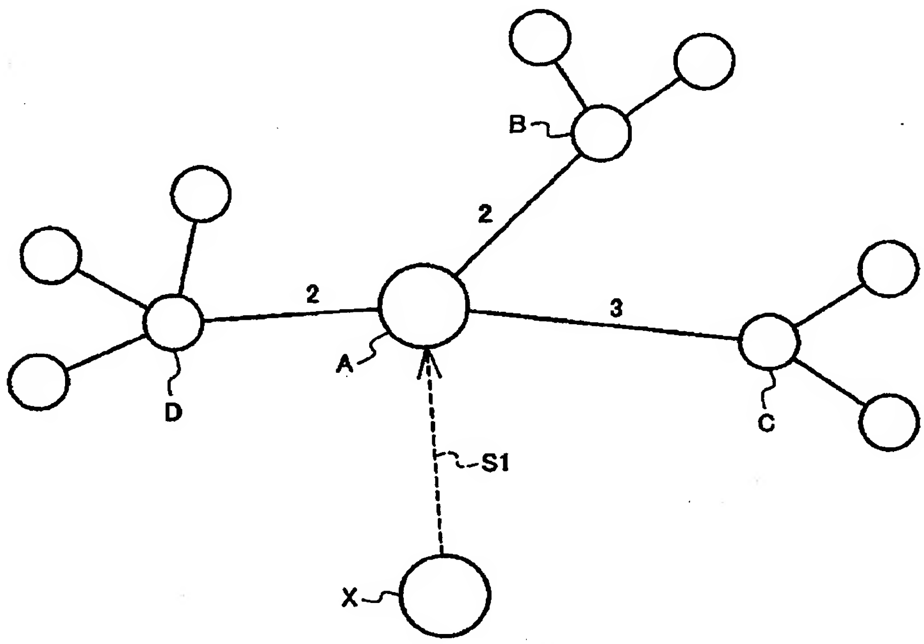
【図１】


ノードX
ノード間接続情報取得部
ノード名
ノードアドレス
メトリック値
ノード数
11
12
バーチャルコネクション確立部
平均メトリック値算出部
コネクション確立部
14
13

【図２】


開始
ノードAからノード間接続情報を取得
S1
ノードA～Dとの間でバーチャルコネクションを確立
S2
ノードA～D間までの経路の平均メトリック値を算出
S3
平均メトリック値が最小のノードDとの間でコネクションを確立
S4
終了

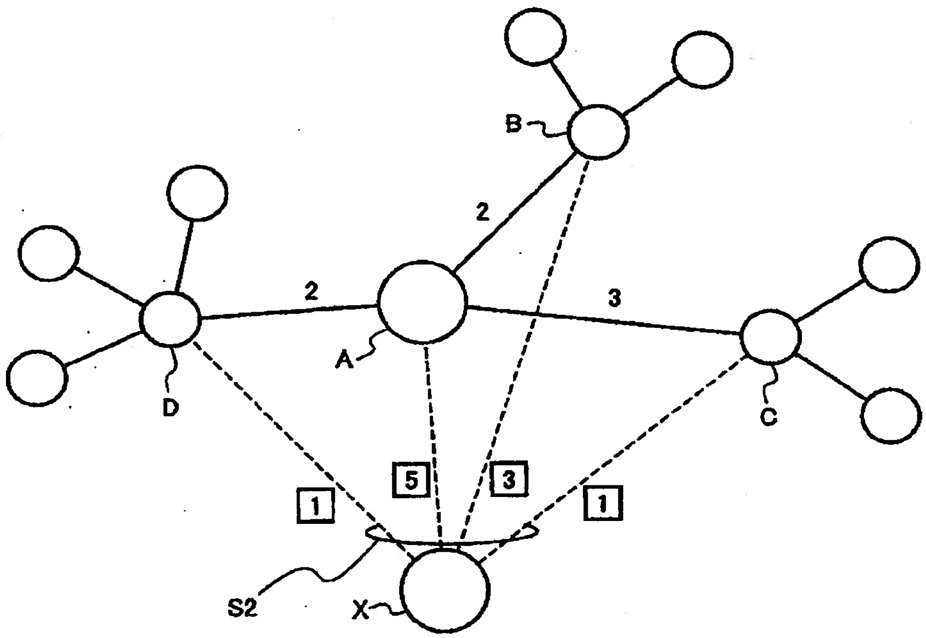
【図3】



【図4】

ノード名	ノードアドレス	メトリック値	ノード数
ノードB	BIP	2	2
ノードC	CIP	3	2
ノードD	DIP	2	3

【図5】



【図6】

ノード名	メトリック値	ノード数	経路名
ノードD	1	3	#D1
ノードA	1+2	0	#A1
ノードB	1+2+2	2	#B1
ノードC	1+2+3	2	#C1

【図7】

ノード名	メトリック値	ノード数	経路名
ノードA	5	0	#A2
ノードD	5+2	3	#D2
ノードB	5+2	2	#B2
ノードC	5+3	2	#C2

【図８】

ノード名	メトリック値	ノード数	経路名
ノードB	3	2	#B3
ノードA	3+2	0	#A3
ノードD	3+2+2	3	#D3
ノードC	3+2+3	2	#C3

【図９】

ノード名	メトリック値	ノード数	経路名
ノードC	1	2	#C4
ノードA	1+3	0	#A4
ノードB	1+3+2	2	#B4
ノードD	1+3+2	3	#D4

【図１０】

$$V_i = \frac{\sum_{i=1}^{n} (V_{Mi} \times N_i)}{\sum_{i=1}^{n} N_i}$$

- n : ノード数
- V_{Mi} : ノードXからノードiまで到達する経路のメトリック値
- N_i : ノードiの隣接ノード数+1
- V_i : バーチャルコネクションiを経由してノードXからノードiまで到達する経路の平均メトリック値

【図１１】

ノードA

$$V_a = \frac{7\times 4+5\times 1+7\times 3+8\times 3}{4+1+3+3} = \frac{78}{11}$$

ノードB

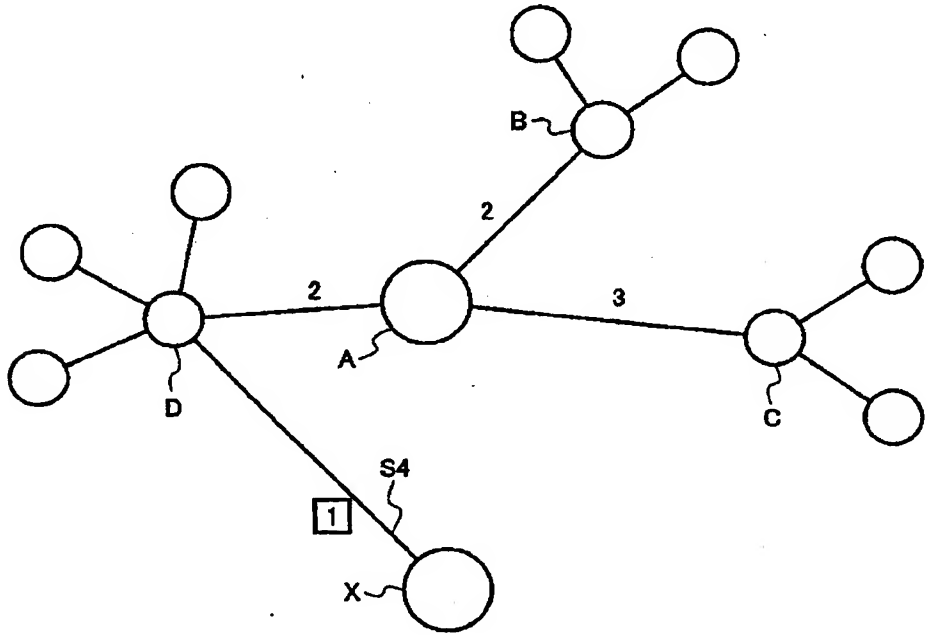
$$V_b = \frac{7\times 4+5\times 1+3\times 3+8\times 3}{4+1+3+3} = \frac{59}{11}$$

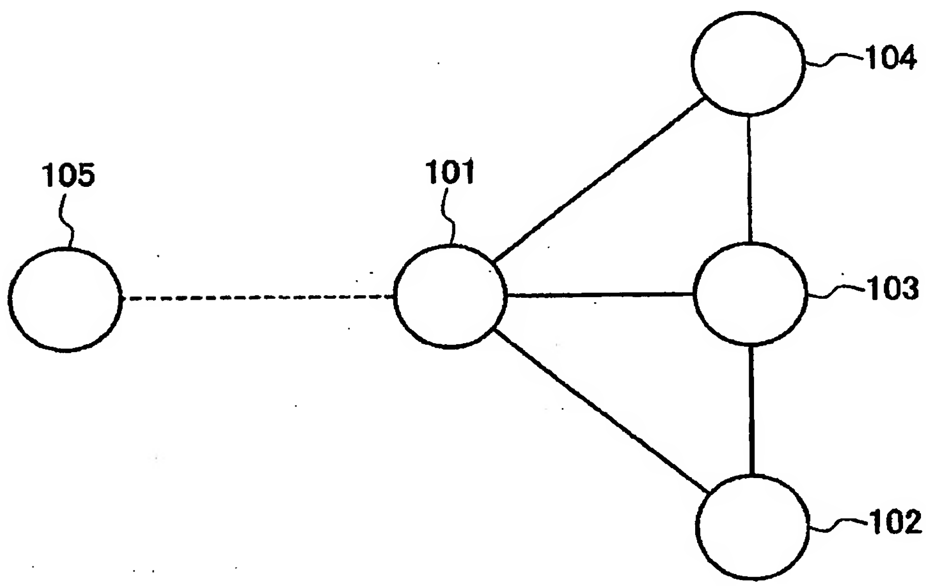
ノードC

$$V_c = \frac{6\times 4+4\times 1+6\times 3+1\times 3}{4+1+3+3} = \frac{50}{11}$$

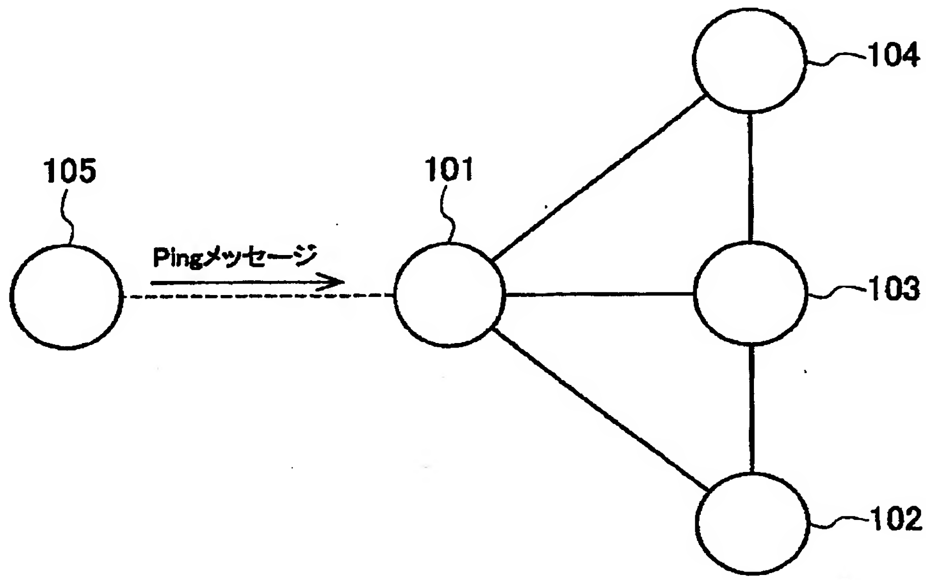
ノードD

$$V_d = \frac{1\times 4+(1+2)\times 1+(1+2+2)\times 3+(1+2+3)\times 3}{4+1+3+3} = \frac{40}{11}$$

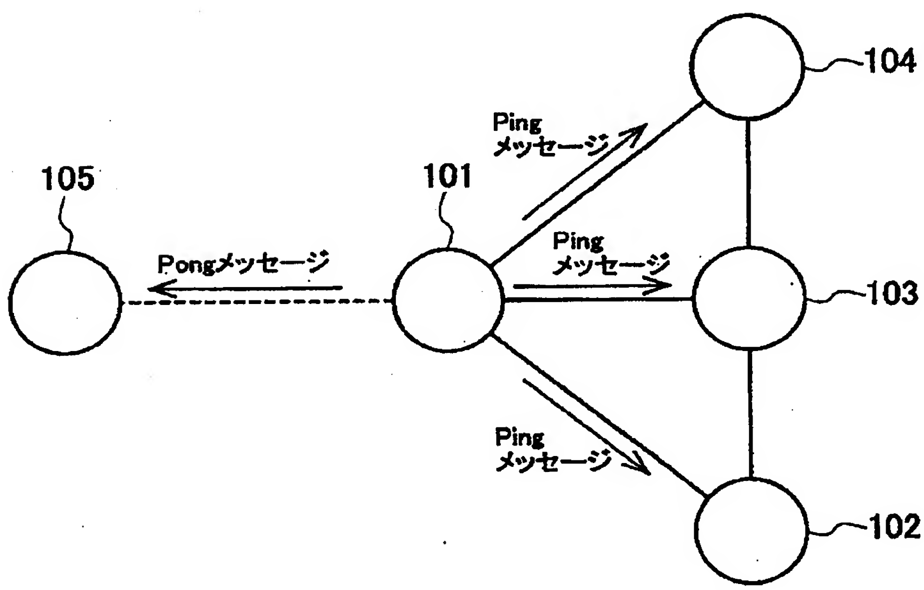
【図１２】


【図１３】


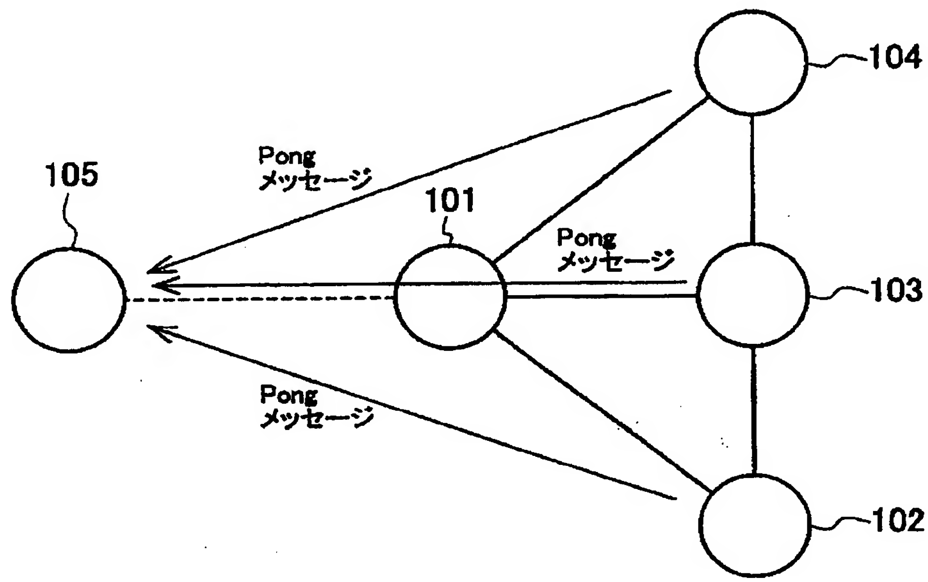
【図１４】


105
101
104
103
102
Pingメッセージ

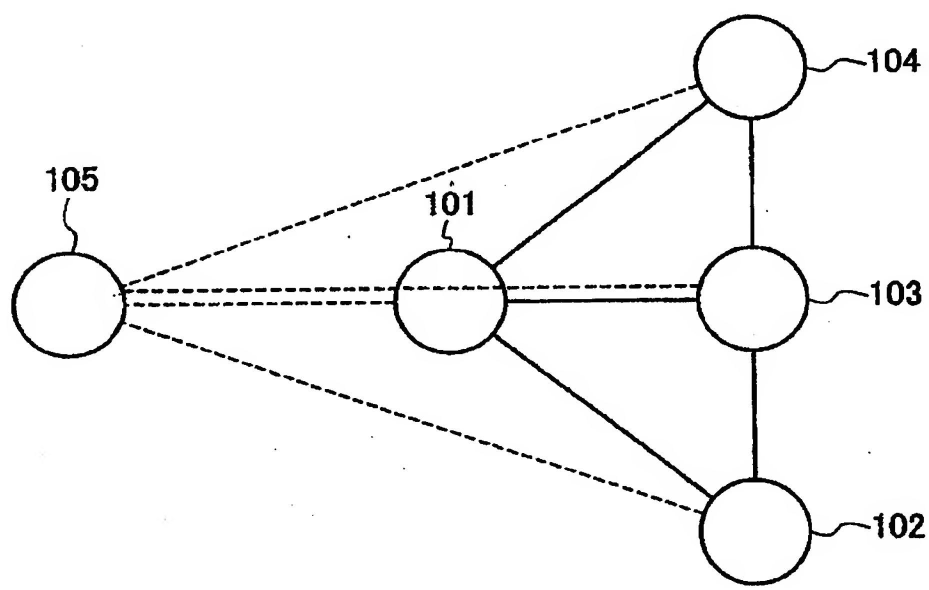
【図１５】


105
101
104
103
102
Pongメッセージ
Ping
メッセージ
Ping
メッセージ
Ping
メッセージ

【図１６】


104
Pong
メッセージ
105
101
Pong
メッセージ
103
Pong
メッセージ
102

【図１７】


104
105
101
103
102